HIGH EXPLOSIVES.

High Explosives: A Practical Treatise. By Capt. E. de W. S. Colver. Pp. xxix + 830. (London: Crosby Lockwood and Son, 1918.) Price 3 guineas net.

CAPT. COLVER has written this large volume with the object of filling "a marked gap in English technical literature, which is sadly deficient in recent information on the subject of high explosives." Though one may not entirely agree with his statement that there is "very little collected information regarding the manufacture, properties, and use of modern high explosives," there is no such complete account as the author gives in this very comprehensive treatise, especially on the manufacture of these important compounds.

In dealing with this subject the author very naturally directs attention to the present difficulties which must be encountered by a writer owing to the impossibility of publishing certain information, so that it became necessary to restrict the work in many important particulars. Similar restrictions must also apply to criticism of the work for fear of transgression.

In the interesting introductory chapter the old controversy over the use of picric acid as an explosive crops up, and the author's statements are contradictory, for on one page it is stated that its detonating properties were discovered by Turpin in 1885, whilst two pages later Sprengel's address before the Chemical Society in 1873, in which he stated that "it is an extremely powerful explosive provided that it is ignited by a powerful detonator," is quoted. Again, later, Capt. Colver writes that it was Turpin's discovery which had given the explosive industry a particularly valuable new explosive.

The following section deals with raw materials and outlines the separation of the primary products. Although petroleum as raw material is not of great importance, more recent records of production than those for 1911 might have been given. No reference is made to the presence of aromatic hydrocarbons in certain petroleums, although for Russian petroleum "benzene" is twice mentioned as the first distillate, when it should obviously have been "benzine" (the specific gravity being 0·725).

In dealing with synthetic phenol, a raw material that has been made on a large scale, only one process of manufacture is referred to, the benzene-sulphonic acid method.

Very complete chapters deal with the nitro-compounds of the aromatic hydrocarbons and of the phenols and naphthols. Trinitrobenzene is stated to be the most suitable of the highly nitrated aromatic hydrocarbons for use as a detonating explosive, the proportion of oxygen giving it advantage over trinitrotoluene, as also does the maximum density attainable, 1·67 as against 1·62 for the toluene derivative. Although slightly more sensitive than T.N.T., it is less so than picric acid. Trinitrobenzene is not at present extensively used, probably owing to the difficulty and expense of manufacture. Attempts to nitrate T.N.T. more highly are shown to result in the formation of trinitrobenzoic acid, or even rupture of the benzene ring with the formation of tetranitromethane, the intense odour of which has been perceptible where decompositions have occurred during manufacture.

Less extensively employed nitro-derivatives, including hexanitrodiphenylamine and the polynitroanilines, and others which have scarcely reached the stage of practical application, are described. Tetranitroaniline is stated to have proved by practical tests the most powerful of all the explosives hitherto used. Several explosives of this class have been employed for aircraft bombs; thus mixtures of two parts of T.N.T. with one part of tetranitroaniline, or of hexanitrodiphenylamine (dipicrylamine), are stated to have been used by the Germans.

Search for suitable raw materials outside the pure chemical compounds has naturally engaged attention, principally in the directions of utilising tar products boiling over a wide range, and petroleum hydrocarbons. Naturally the nitro-products are complex in character; thus from coal-tar naphthas mixtures of solid and liquid nitro-products are obtainable, those from fractions boiling above 200° C. containing many nitro-derivatives of the naphthalene series. The nitro-products from petroleums are stated to consist generally of uncrystallisable masses of reddish-brown colour suitable only for certain plastic explosives. The possibility of obtaining generally useful materials by direct nitration does not appear promising. A sounder procedure would appear to lie in "cracking" the oils for the production of aromatic hydrocarbons which can be separated and then nitrated.

Indirectly prepared nitro-derivatives of paraffin hydro-carbons are of considerable interest, and the author considers that here is a profitable field of research. The remarkable substance tetranitromethane [$C(NO_2)_4$] has been patented as an oxidiser for other organic compounds, as in the Sprengel type of explosives. This compound is comparatively non-volatile, has no acid properties, is completely stable, insoluble in water, and not affected by it. Hexanitroethane [$C_2(NO_2)_6$] forms colourless crystals, which are extremely insensitive to percussion and friction.

Considerable space is given to the German rules and regulations governing the manufacture, etc., of explosives, the author considering that the ripe experience of the Germans justifies this. British regulations are not dealt with. There is a useful section on the toxic effect of raw materials and products. Some contradiction is evident over the relative liability of more or less highly nitrated products to produce ill-effects, for the general statement is made that the toxic effect of the lower grades of T.N.T. is greater than that of the pure substance, whilst in a previous passage the statement occurs that in general with the various nitrobenzenes (and nitrotoluenes), "as the

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number of the nitro-groups increase, the compounds have a proportionally greater toxicity."

A useful section deals with the manipulation and working up of the finished explosives, grinding, mixing, the filling of shells by plain casting, casting under pressure to increase the density of the charge, and by pressing the solid charge.

The later chapters are devoted to questions on the use of explosives, the measurement of pressures, energy, etc.; then follows an appendix containing a comprehensive review of patents (which is supplemented later by a "Patents Register"). A short further appendix deals with specifications. This last section is extremely meagre, but possibly restrictions were placed on the author in respect to British specifications, and moreover those handling the materials have to be familiar with the requirements.

The volume is inconveniently large; much space might have been saved with advantage. For example, graphic formulæ are unnecessarily large; in one instance three formulæ almost fill one page; subdivision into separate chapters where collection under one heading was possible has led to much blank space, and some very simple diagrams have a whole page devoted to each.

IS PSYCHOLOGY ONE OF THE NATURAL SCIENCES?

Psychological Principles. By Dr. James Ward. (The Cambridge Psychological Library.) Pp. xiv+478. (Cambridge: At the University Press, 1918.) Price 21*s.* net.

PSYCHOLOGY, ever held in high honour as a philosophical science, is to-day claiming to be one of the natural sciences. Sometimes it is distinguished as the new psychology. It regards its subject-matter as amenable to treatment in laboratories, and in two directions, one educational and industrial, the other medical and therapeutic, it appears to have established its claim to be assigned a special realm of scientifically classified facts.

Since 1884, the year in which Dr. Ward wrote the famous "Encyclopædia Britannica" article, the output of this new psychology in books and journals and society proceedings has been enormous, its variety almost defying classification. It ranges from statistics and correlations to elaborate hypotheses of the fundamental nature of the reality of psychical phenomena. Throughout this whole period Dr. Ward's "Encyclopædia" article has stood almost unchallenged in its authority as the exposition of the principles which must govern every science of the soul. There are only two books which can compare with it in this respect—namely, James's "Principles of Psychology" and Stout's "Manual," and these are in no sense rivals, for each of the three is unique. Yet we cannot help sympathising with Dr. Ward's disappointed feeling that the conditions necessarily attaching to an article in an encyclopædia are a serious handicap to its usefulness compared with the unrestricted form of the separate treatise. At last, however, we are allowed to have this important work in a volume, and the wonderful thing is that it appears, not as an overdue promise in the fulfilment of which we have lost interest, but as a new work with all the freshness of youth; and the large additions to the original article are not makeshift appendages, but natural developments.

No one who reads this book can fail to appreciate the significant service Dr. Ward has rendered to psychology. It is evident alike in the paths he follows and in those which he avoids as side-tracks, or turns away from as false routes. We are not invited, for example, to begin with a more or less detailed description of the nervous system, and we are therefore spared altogether that illusion which so powerfully influences the psychologists whom it fascinates, the illusion that it is only a little gap in our science, an unfortunate hiatus we have not yet succeeded in bridging, which prevents us passing directly from physiology to psychology, from the science of the nervous system to the science of the mind. Again, with a clear conception of its utter futility, Dr. Ward rejects the notion that psychical facts belong to the same order of reality as physical facts, differing from them only in their diaphaneity and elusiveness, but capable of being mathematically treated by cunningly devised psycho-physical apparatus. Dr. Ward's attitude towards such method is shown in a characteristic note in the preface, in which, apologising for the retention of the chapter on "Memorising, Rhythmising, and Reading," originally inserted "by way of illustrating the so-called new psychology," he adds: "If there is one chapter more than another in the book which may be 'skipped,' it is this."

The greatness of this book is not in its negations, but in the clear and masterly way in which it sets forth the principles that govern psychology. No development of the science, or possible discovery, can affect these. First and foremost is the principle of the unity of the subject of experience with his experience. This is fundamental in Dr. Ward's view, and insisted on in striking arguments and clear expressions. The point of view of psychology is individualistic. Psychology is the science of individual experience. As presented to an individual, "the whole choir of heaven and furniture of earth" may belong to psychology.

In close connection with this definition of the subject-matter and scope of psychology is the principle of the indissolubility of the subject-object relation in experience, and the inseparability of its factors into subjects of experience on one hand, and objects of experience on the other. The subject-object relation is not a dualism of two terms, but a duality in unity. The importance of this principle in regard to the status of psychology as a science can be easily seen. In the physical sciences we select among the objects of experience special groups and classes and treat them on the assumption that they are in their essence what they are known to

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